

# PSET 3: Simple Harmonic Motion

SI LEADER: Stephen Iota ([siota001@ucr.edu](mailto:siota001@ucr.edu))

COURSE: Physics 40B (Spring 2019), Prof. Barsukov

DATE: April 24, 2019

## 1 Phenomenology

- (a) Explain what an *eigenfrequency* is.
- (b) Consider a mass  $m$  on a spring with a force constant  $k$ . If I increase the mass, what happens to the spring's eigenfrequency?
- (c) What happens to the eigenfrequency if I decrease the spring constant  $k$ ?
- (d) Is  $\cos x$  an even or odd function? What does that mean? How about  $\sin x$ ?

## 2 Describing SHM

Consider an oscillator described by

$$\frac{d^2x}{dt^2} = -\frac{k}{m}x(t).$$

Derive the following quantities:

- (a) position  $x(t)$
- (b) velocity  $v(t)$
- (c) acceleration  $a(t)$
- (d) angular frequency  $\omega$
- (e) period  $T$
- (f) potential energy  $U$

Using what you just derived, what would happen to a spring's maximum speed if its total energy is doubled?

### 3 The dynamics of SHM

- (a) The motion of a particle is given by  $x(t) = (25\text{cm}) \cos 10t$ , where  $t$  is in seconds. What is the first time at which the kinetic energy is twice the potential energy?

- (b) A spring is standing upright on a table with its bottom end fastened to the table. A block is dropped from a height 3.0 cm above the top of the spring. The block sticks to the top end of the spring and then oscillates with an amplitude of 10 cm. What is the oscillation frequency?